GENOMES to LIFE
BIOLOGICAL SOLUTIONS FOR ENERGY CHALLENGES
INNOVATIVE APPROACHES ALONG UNCONVENTIONAL PATHS

U.S. Department of Energy

Genomes To Life Program

Office of Science
U.S. Department of Energy

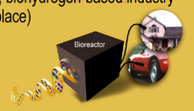
U.S. Department of Energy — *Expand Energy Resources* • *Enhance Energy Conservation* • *Promote Carbon Management*

The revolution in biology triggered by the Human Genome Project, first launched in 1986 by DOE, now promises far-reaching benefits to our nation and our environment.

Today, DOE is poised to take the next vital steps with the Genomes to Life program.

Using Systems Biology
For Energy and Environmental Payoffs

Within a Decade	*Long Term*
Enable rapid detection of agents and identify molecular targets for new antivirals and antibacterials	**2010** Enhance biothreat agent detection and response
Develop knowledge base for cost-effective cleanup strategies	**2020** Save billions of dollars in toxic waste cleanup and disposal
Understand Earth's natural carbon cycle and design strategies for enhanced carbon capture	**2040** Help stabilize atmospheric carbon dioxide to counter global warming
Increase biological sources of fuels and electricity	**2050** Contribute to U.S. energy security (e.g., biohydrogen-based industry in place)

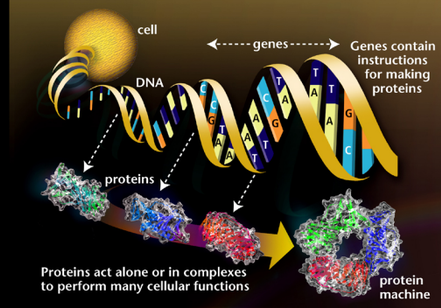


Genomes to Life
DOEGenomesToLife.org

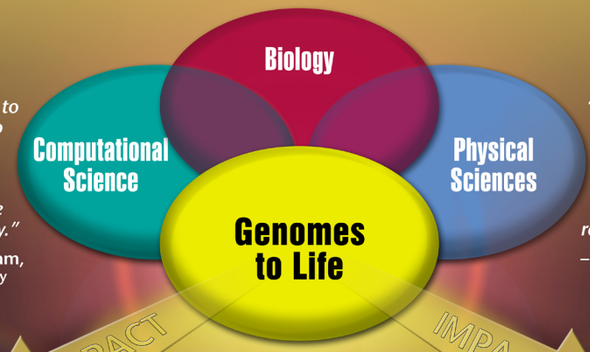
Office of Science
www.sc.doe.gov

DOE Biological and Environmental Research Program — Serving Science and Society

ASCR



"I believe we need to leapfrog the status quo and prepare for a future that, under any scenario, requires a revolution in how we find, produce and deliver energy."
– Spencer Abraham, Secretary of Energy



"America is a leader in technology and innovation. We all believe technology offers great promise to significantly reduce emissions"
– President George W. Bush

Yielding a fundamental, comprehensive, and systematic understanding of life

EXPLORING SYSTEMS BIOLOGY

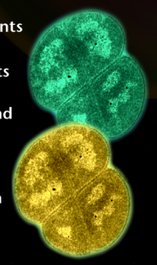
- Protein complexes (machines) performing life functions
- Gene regulatory networks controlling these processes
- Diverse functional abilities in natural microbial communities
- New computational capabilities for modeling complex living systems

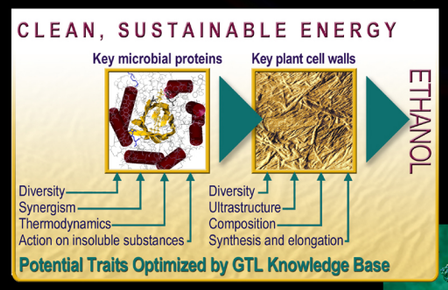
New and Enhanced Products and Processes

Microbes

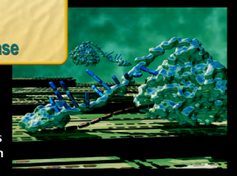
Obtain more efficient enzyme components and functional systems for

- New feedstocks and biobased products (e.g., plastic analogs)
- Improved rates and yields for fossil and biomass processing
- More specific and benign operating conditions
- New energy sources such as hydrogen
- More efficient carbon management methods





Enhanced plant qualities and bioprocesses can yield more energy- and cost-effective products

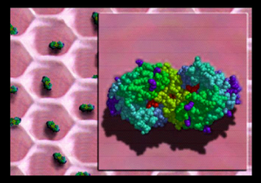


Microbial protein machines can break down cellulose in plant cell walls into simple sugars that can be fermented to ethanol. Although the process today is too inefficient for commercial production, fundamental knowledge gained in Genomes to Life can be applied to develop more efficient methods.

Plants

- Modify chemical and structural compositions by designing more effective enzymes (proteins) and their functional systems
- Extend usable land base and biofeedstocks produced
- Produce value-added products

- Compact crown and root system
- Optimal allocation to biomass components
- Higher harvest efficiency
- Higher productivity per unit area
- Greater product yield per tree
- Non-flowering

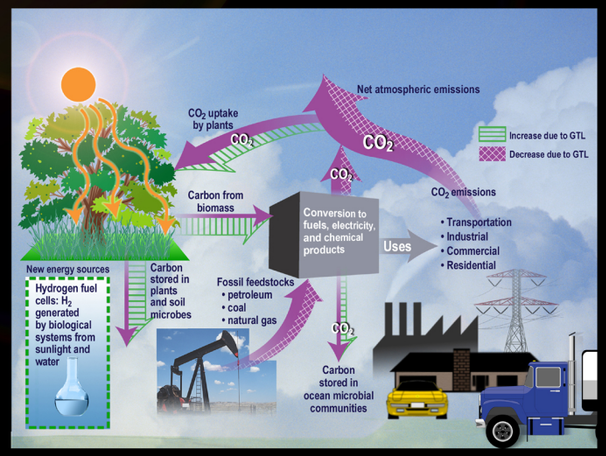


Biology + Nanotechnology for Energy Applications

Engineered protein machines can be embedded in synthetic nanomembranes that may one day break down cellulose more efficiently or produce hydrogen for fuel cells

Global Impact

- **Reduce dependence on imported oil**
- **Decrease net atmospheric CO_2 emissions**



Payoffs for Energy

- Biobased resources and products
- Biobased processes to replace energy-intensive thermochemical methods
- Higher yields of usable bioenergy feedstocks
- Increased carbon management in plants and microbes
- Hydrogen for fuel cells